

PART-I : PHYSICS

1) The volume of a gas is dependent on area and length of the container. Which of the expressions is/are dimensionally incorrect :

(1) $V = A \times \ell$

(2) $V = \frac{A^2}{\ell}$

(3) $V = \frac{A}{\ell}$

(4) $V = A^3 \ell^{-3}$

2) The length of a rectangular sheet is 1.5 cm and breadth is 1.203 cm. The area of the face of rectangular sheet to the correct number of significant figures is :

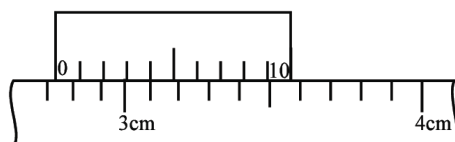
(1) 1.8045 cm²

(2) 1.804 cm²

(3) 1.805 cm²

(4) 1.8 cm²

3) The diagram shows part of the vernier scale on a pair of calipers.



Which reading is correct ?

(1) 2.74 cm

(2) 3.10 cm

(3) 3.26 cm

(4) 3.64 cm

4) A particle is projected vertically upwards in vacuum with a speed u .

(1) When it rises to half its maximum height, its speed becomes $u/2$

(2) When it rises to half its maximum height, its speed becomes $\frac{u}{\sqrt{2}}$

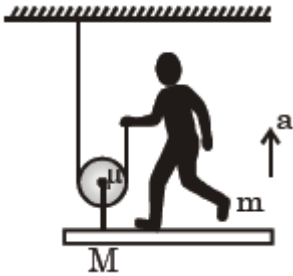
(3) The time taken to rise to half its maximum height is half the time taken to reach its maximum height

(4) The time taken to rise to one-fourth of its maximum height is half the time taken to reach its maximum height

5) A go-kart travels around a circular track at a constant speed. Which of these is a true statement?

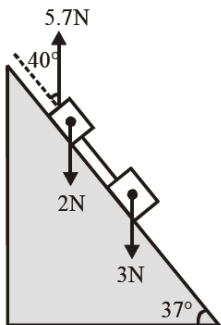
- (1) The go-kart has a constant velocity
- (2) The go-kart has zero acceleration
- (3) Both (1) and (2) are true
- (4) Neither (1) nor (2) is true.

6) A person stands on a platform and pulley system as shown in the figure. The masses of platform, person and pulley are M , m and μ respectively. The rope is massless. Let the person pull up on the rope so that he has acceleration a upwards. Tension in the rod connecting the pulley to the platform is :



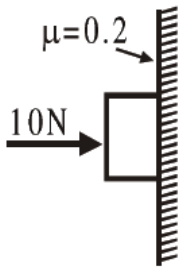
- (1) $(M + m + \mu)(g + a)$
- (2) $(M + 2m + \mu)(g + a)$
- (3) $(2M + 2m + \mu)(g + a)$
- (4) $(2M + m + 2\mu)(g + a)$

7) Two blocks are connected by a string, and are pulled by a force of 5.7 N on a frictionless surface as shown in the figure. If the string breaks suddenly, calculate the acceleration of the heavier block along the plane.



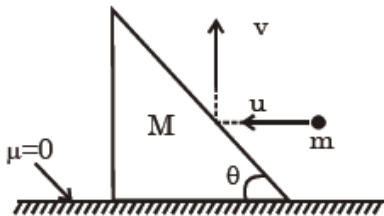
- (1) 0.87 ms^{-2}
- (2) 2.60 ms^{-2}
- (3) 6 ms^{-2}
- (4) 5.00 ms^{-2}

8) A minimum horizontal force of 10 N , is necessary to hold a block stationary against a wall. The coefficient of friction between the block and the wall is 0.2 . Contact force by the wall on the block is



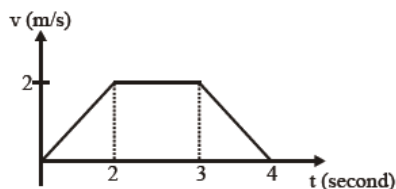
- (1) 10 N
- (2) 2 N
- (3) 12 N
- (4) $2\sqrt{26}$ N

9) A ball of mass 'm' moving horizontally with velocity 'u' hits a wedge of mass M. The wedge is on smooth floor. If after striking with wedge the ball starts moving in vertical direction and the wedge starts moving in horizontal plane. The coefficient of restitution (e) will be :



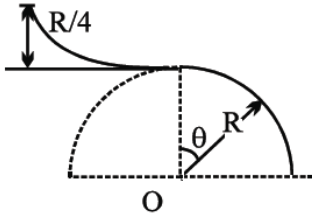
- (1) $\frac{m}{M} + \tan^2 \theta$
- (2) $\frac{M}{m} + \cot^2 \theta$
- (3) $\frac{m}{M} + \cot^2 \theta$
- (4) $\frac{M}{m} + \tan^2 \theta$

10) An object of mass 2kg is kept in a lift which moves upwards. Velocity of lift varies with time as shown in the graph. Work done by normal contact force of lift on the block, during the time $t = 0$ to $t = 4$ s is :-



- (1) 20 joule
- (2) - 20 joule
- (3) 100 joule
- (4) -100 joule

11) A skier plans to ski a smooth fixed hemisphere of radius R. He starts from rest from a curved smooth surface of height (R/4). The angle θ at which he leaves the hemisphere is

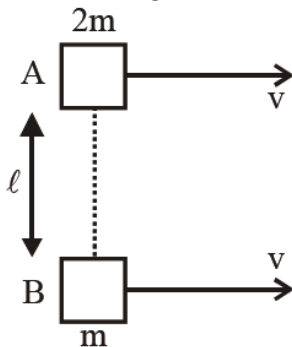


- (1) $\cos^{-1} (2/3)$
- (2) $\cos^{-1} (5/\sqrt{3})$
- (3) $\cos^{-1} (5/6)$
- (4) $\cos^{-1} (5/2\sqrt{3})$

12) A generator's flywheel, which is a homogeneous cylinder of radius R and mass M , rotates about its longitudinal axis. The linear velocity of a point on the rim (side) of the flywheel is n . What is the kinetic energy of the flywheel ?

- (1) $K = \frac{1}{2} M n^2$
- (2) $K = \frac{1}{4} M n^2$
- (3) $K = \frac{1}{2} M n^2 / R$
- (4) $K = \frac{1}{2} M n^2 R$

13) Two particles A and B of masses $2m$ and m respectively are moving with same velocity v as shown in figure. At instant shown in figure, choose **correct** option from the following :-



Total kinetic energy of system (A + B) in the frame of centre of mass is

- (1) $\frac{3mv^2}{2}$
- (2) Linear momentum of A in the frame of B has magnitude mv
- (3) Angular momentum of A in the frame of B has magnitude $2mvl$
- (4) Angular velocity of line joining A and B has magnitude zero.

14) The minimum energy required to launch a m kg satellite from earth's surface in a circular orbit at an altitude of $2R$, where R is the radius of earth will be

- (1) $3mgR$

- (2) $\frac{5}{6}mgR$
 (3) $2mgR$
 (4) $\frac{1}{3}mgR$

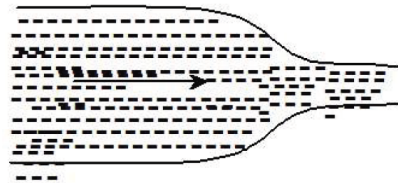
15) Copper of fixed volume V is drawn into wire of length ℓ . When the wire is subjected to a constant force f , then the extension produced in wire is $\Delta\ell$. Which of the following graph is straight line ?

- (1) $\Delta\ell$ vs $\frac{1}{\ell^2}$
 (2) $\Delta\ell$ vs ℓ
 (3) $\Delta\ell$ vs $\frac{1}{\ell}$
 (4) $\Delta\ell$ vs ℓ^2

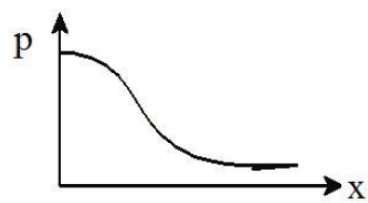
16) A solid floats with $\frac{2}{3}$ of its volume immersed in a liquid and with $\frac{3}{4}$ of its volume immersed in another liquid. What fraction of its volume will be immersed if it floats in a homogenous mixture formed of equal volumes of the liquids?

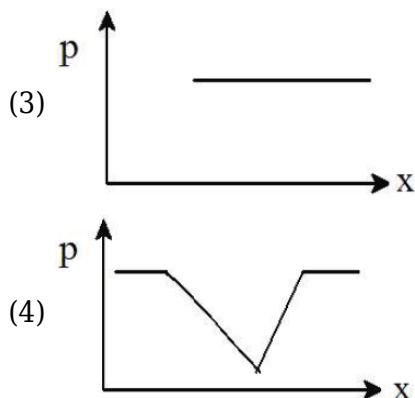
- (1) $\frac{6}{7}$
 (2) $\frac{8}{11}$
 (3) $\frac{11}{16}$
 (4) $\frac{12}{17}$

17) Water flows through a frictionless duct with a cross-section varying as shown in figure .



Pressure p at points along the axis is represented by

- (1) 
 (2) 



18) The velocity of sound at temperature 27°C is V then velocity will be $2V$ at

- (1) 54°C
- (2) 327°C
- (3) 927°C
- (4) -123°C

19) The intensity in W/m^2 of a 70 dB noise is :-

- (1) 10^{-5}
- (2) 10^{-7}
- (3) 10^5
- (4) 10^7

20) A metal ball immersed in Alcohol weights W_1 at 0°C and W_2 at 50°C . The coefficient of cubical expansion of the metal $(\gamma)_m$ is less than that of alcohol $(\gamma)_{Al}$. Assuming that density of metal is large compared to that of alcohol, it can be shown that

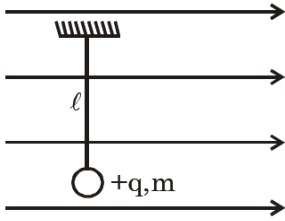
- (1) $W_1 > W_2$
- (2) $W_1 = W_2$
- (3) $W_1 < W_2$
- (4) Any of 1 , 2 or 3

21) Certain perfect gas is found to obey $PV^{3/2} = \text{constant}$ during an adiabatic process. If such a gas at initial temperature T is adiabatically compressed to half the initial volume, its final temperature will be

- (1) $\sqrt{2}T$
- (2) $2T$
- (3) $2\sqrt{2}T$
- (4) $4T$

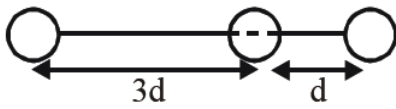
22) A bob of mass m is suspended from a light string as shown. When string is vertical, then bob is imparted horizontal velocity $\sqrt{2gl}$ towards right. System is placed in uniform electric field . Then find out tension in the string, when first time string becomes horizontal

$$E = \frac{mg}{q}$$



- (1) $T = 0$
- (2) $T = mg$
- (3) $T = 3mg$
- (4) $T = 2mg$

23) Two small spheres each having charge ' q ' are fixed to the end of a light non-conducting frictionless rod in gravity free space. A third identical movable sphere (having mass ' m ' and charge ' q ') is released from rest from the position as shown in the figure. Find the maximum speed of the middle sphere.

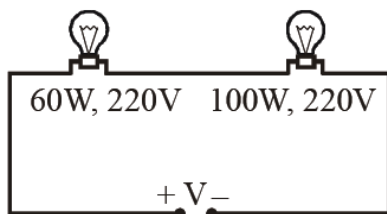


- (1) $\frac{2q}{3} \sqrt{\frac{K}{md}}$
- (2) $\frac{q}{3} \sqrt{\frac{K}{md}}$
- (3) $\frac{4q}{3} \sqrt{\frac{K}{md}}$
- (4) $q \sqrt{\frac{2K}{3md}}$

24) The drift velocity of electrons in a metallic conductor carrying a current is usually of the order of

- (1) 1 cm/s
- (2) 10 m/s
- (3) 10^4 m/s
- (4) 10^8 m/s

25) Two bulbs rated 220 V, 100 W and 220 V, 60W are connected in series across a voltage supply V . The bulbs can be assumed as purely resistive and they cannot withstand a voltage more than their voltage rating. Select the **incorrect** alternative :-



- (1) When $V = 220$ V, total power output is 37.5 W
- (2) When $V = 220$ V, $P_{60} > P_{100}$

(3) The maximum safe value of V is 440 V

(4) The maximum safe value of V is 352 V

$$\Phi_B = \pm N \text{ Wb}$$

26) The magnetic flux through each of five faces of a neutral playing dice is given by where N ($= 1$ to 5) is the number of spots on the face. The flux is positive (out-ward) for N even and negative (inward) for N odd. What is the flux through the sixth face of the die ?

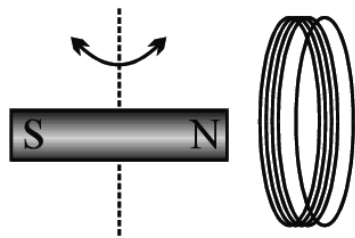
(1) 3 Wb

(2) 4 Wb

(3) - 3 Wb

(4) - 4 Wb

27) The bar magnet is oriented so that it lies along the axis of a coil of wire as shown in the diagram. If the magnet is quickly rotated about a vertical axis until the opposite end (south pole) points toward the coil, the direction of the induced current (as seen from the magnet) in the loops of wire in the coil will be



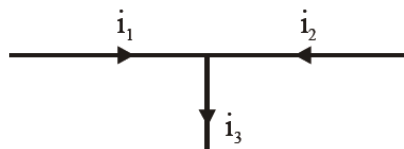
(1) Without meaning because there will no induced emf or current.

(2) Clockwise if the magnet is rotated clockwise, and vice versa.

(3) Counter-clockwise if the magnet is rotated clockwise, and vice versa.

(4) The same, whether the magnet is rotated clockwise or counter-clockwise.

28) In the given figure if $i_1 = 3 \sin \omega t$ and $i_2 = 4 \cos \omega t$, then i_3 is



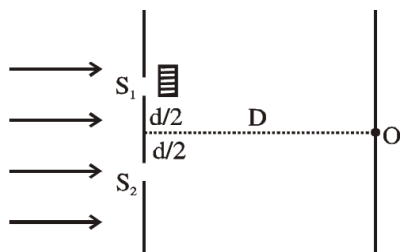
(1) $5 \sin (\omega t + 53^\circ)$

(2) $5 \sin (\omega t + 37^\circ)$

(3) $5 \sin (\omega t + 45^\circ)$

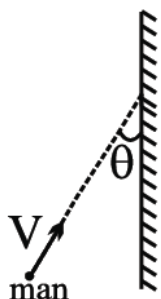
(4) $5 \cos (\omega t + 53^\circ)$

29) When a perfectly transparent glass slab ($\mu = 1.5$) is introduced in front of upper slit of a usual double slit experiment, the intensity at 'O' reduces to $1/2$ times of its earlier value. Minimum thickness of slab would be [Assume that slab does not absorb any energy].



- (1) λ
- (2) $\frac{\lambda}{2}$
- (3) $\frac{\lambda}{4}$
- (4) 2λ

30) A person walks at a velocity V in a straight line forming an angle θ with the plane of a plane mirror. The velocity V_{rel} with which he approaches his image?



- (1) $2V \sin \theta$
- (2) $2V$
- (3) $2V \cos \theta$
- (4) $\frac{V}{2} \sin \theta$

PART-II : CHEMISTRY

1) Consider following set of quantum number for an electron in an atom

$$\ell = 1, m = 0, s = +\frac{1}{2}$$

Which of the following is **CORRECT** ?

- (1) It belongs to K shell
- (2) Maximum probability of this electron is in double dumb bell shape orbital
- (3) Least possible principal quantum number = 3
- (4) In same atom, this set is possible for some other electron also

2) Which of the following order is/are **correct** ?

- (1) $\text{Li}^+ < \text{Na}^+ < \text{K}^+$: Hydrated radius
- (2) $\text{Na}^+ < \text{Mg}^{+2} < \text{Al}^{+3}$: Ionic radius
- (3) $\text{F} < \text{Cl} > \text{Br}$: Electron affinity

(4) $\text{Cl} - \text{OH} < \text{Br} - \text{OH} < \text{I} - \text{OH}$: Acidic character

3) Which of the following statement is **correct**

(1) Mg^{+2} has greater ionic radius than Li^+

(2) Shielding constant value for 4s & 3d e^- is same in scandium

(3) H^- is the smallest anion in periodic table

(4) F has highest negative $\Delta H_{\text{eg}} (\text{I})$

4) Which among the following are not isostructural?

(1) XeO_2F_2 , SF_4

(2) CO_2 , I_3^-

(3) NO_3^- , CO_3^{2-}

(4) ClF_3 , XeF_2

5) HI reacts with H_2SO_4 , then reduced product in the reaction could be

(1) SO_3

(2) H_2S

(3) I_3^-

(4) IO_3^-

6) 'X' gas has rotten fish smell, when react with CuSO_4 solution, then what is the colour of ppt.

(1) Yellow

(2) Brown

(3) Red

(4) Black

7) Among the following, the coloured compound is

(1) $\text{K}_2[\text{Cd}(\text{CN})_4]$

(2) $\text{K}_3[\text{Cu}(\text{CN})_4]$

(3) $\text{K}_3[\text{Fe}(\text{CN})_6]$

(4) $[\text{Cu}(\text{CH}_3\text{CN})_4]\text{BF}_4$

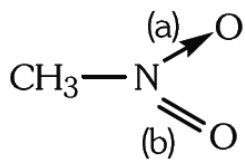
8) In coming years, skin related disorders will become more common due to -

(1) Air pollution

(2) Excessive use of detergents

(3) Depletion of ozone layer

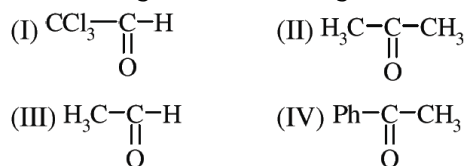
(4) Water pollution



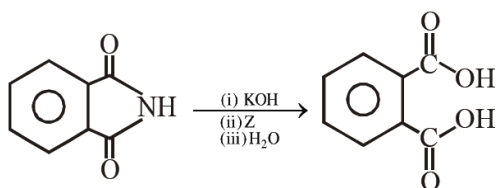
9) In nitromethane, two N - O bond lengths are:

- (1) $a = b$
- (2) $a > b$
- (3) $b > a$
- (4) Can not be compared

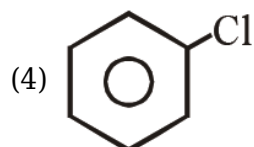
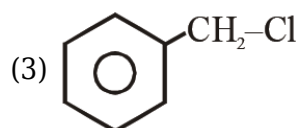
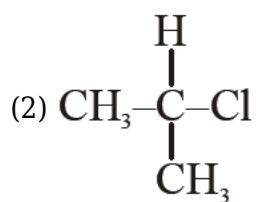
10) Arrange the following in order of their reactivity towards CH_3MgBr ?



- (1) $\text{I} > \text{IV} > \text{III} > \text{II}$
- (2) $\text{II} > \text{I} > \text{III} > \text{IV}$
- (3) $\text{I} > \text{II} > \text{III} > \text{IV}$
- (4) $\text{I} > \text{III} > \text{II} > \text{IV}$



11) + Primary amine Z may not be :

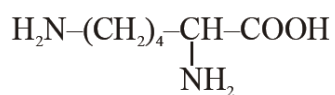


12) Match the column :

	Polymer		Commercial name
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i	Polyester of glycol and phthalic acid	a	Novolac
ii	Copolymer of 1,3-butadiene and styrene	b	Glyptal
iii	Phenol and formaldehyde resins	c	Buna-S
iv	Polyester of glycol and terephthalic acid	d	Buna-N
v	Copolymer of 1,3-butadiene and acrylonitrile	e	Dacron

- (1) i-b, ii-c, iii-e, iv-a, v-d
 (2) i-b, ii-c, iii-a, iv-e, v-d
 (3) i-e, ii-c, iii-a, iv-b, v-d
 (4) i-e, ii-c, iii-b, iv-a, v-d



13) Lysine, is

- (a) α -amino acid
 (b) Basic amino acid
 (c) Amino acid synthesis in body
 (d) β -Amino acid

- (1) a, b, c
 (2) b, c
 (3) b, d
 (4) a, b

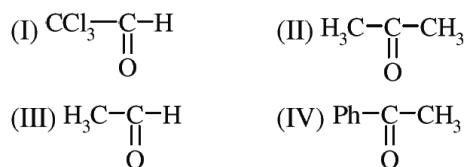
14) Which of the following reactions will not result in the formation of carbon-carbon bond

- (1) Friedel Craft's alkylation
 (2) Reimer Tieman reaction
 (3) Cannizaro reaction
 (4) Wurtz reaction

15) o-nitrophenol and p-nitrophenol are separated by :

- (1) Steam distillation
 (2) Simple distillation
 (3) Fractional distillation
 (4) Distillation under reduced pressure

16) Arrange the following in order of their reactivity towards CH_3MgBr ?

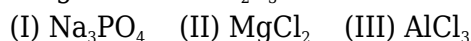


- (1) I > IV > III > II
 (2) II > I > III > IV
 (3) I > II > III > IV
 (4) I > III > II > IV

17) Which of the following detergent belong to ABS - group

- (1) Sodium Lauryl sulphate
 (2) Sodium dodecyl benzene sulphonate
 (3) Cetyltrimethyl ammonium bromide
 (4) Pentaerythrityl stearate

18) Arrange the following electrolytes in the increasing order of coagulation power for the coagulation of As_2S_3 solution



- (1) I > II > III
 (2) I < II < III
 (3) I = III < II
 (4) III < I < II

19) The emf of the cell $\text{Ag(s)}|\text{Ag}^+(1\text{M})||\text{I}^-(1\text{M})|\text{AgI(s)}|\text{Ag(s)}$ is E. The solubility product of AgI can be expressed as

(1) $K_{\text{sp}} = \frac{nF}{2.303 RT} \log E$

(2) $\ln K_{\text{sp}} = nF \left[\frac{\partial E}{\partial T} - E \right]$

(3) $\ln K_{\text{sp}} = \frac{nF}{E}$

(4) $\log K_{\text{sp}} = \frac{nFE}{2.303 RT}$

20) In which of the following case $K_p < K_c$ at 298 K

- (1) Formation of NO(g) from elements
 (2) Formation of $\text{NH}_3(\text{g})$ from elements
 (3) Formation of NaBr(s) from elements
 (4) Formation of $\text{FeBr}_2(\text{s})$ from elements

21) An atomic solid crystallizes in bcc lattice if circumference (surface) of atoms at the adjacent

corners are separated by 54 pm then edge length of bcc unit cell is $(\sqrt{3} = 1.7)$

- (1) 450 pm
- (2) 108 pm
- (3) 216 pm
- (4) 360 pm

22) If the average velocity of N_2 molecules is 0.3 m/sec. at 270C, then the velocity of 0.6 m/sec will take place at :

- (1) 273 K
- (2) 927 K
- (3) 1000 K
- (4) 1200 K

23) A gas absorbs 200 J heat and expands by 500 cm^3 against a constant pressure of $2 \times 10^5 \text{ Nm}^{-2}$. The change in its internal energy will be

- (1) -200 J
- (2) -100 J
- (3) 100 J
- (4) 0

24) pH of a buffer solution decreases by 0.02 units when 0.12 g of acetic acid is added to 250 mL of a buffer solution of acetic acid and potassium acetate at 27°C. The buffer capacity of the solution is -

- (1) 0.1
- (2) 0.2
- (3) 2.5
- (4) 0.4

25) Three different sample of radioactive substance U^{235} , $U^{235}F_6$, $U_3^{235}O_8$ each containing equal moles of given substance are taken then

- (1) Activity of U_3O_8 will be minimum
- (2) Specific activity of U_3O_8 will be maximum
- (3) On increasing temperature activity of all three sample will increase
- (4) 7 α -particle will be obtained when U^{235} decay to stable nuclei

26) The position of Cl^- ions in NaCl structure are-

- (1) Corners of the cube
- (2) Centres of faces of the cube
- (3) Corner as well as centres of faces of the cube

(4) Edge centres of the cube

27) Ratio of active masses of 22g CO₂, 3g H₂ and 7g N₂ in a gaseous mixture :-

- (1) 22 : 3 : 7
- (2) 0.5: 3 : 7
- (3) 1 : 3 : 1
- (4) 1 : 3 : 0.5

28) Isotonic solutions have the same

- (1) Density
- (2) Molar concentration
- (3) Normality
- (4) None

29) A solution of 1.25g of a non-electrolyte in 20g of water freezes at 271.94 K. If K_f = 1.86 K/m, then the molecular wt. of the solute will be

- (1) 207.8 g/mol
- (2) 179.79g
- (3) 209.6g/mol
- (4) 109.g/mol

30) Which gas effuses fastest under identical conditions

- (1) N₂
- (2) O₂
- (3) Cl₂
- (4) CH₄

PART-III : MATHEMATICS

1) Vector equation of the plane

$\vec{r} = \hat{i} - \hat{j} + \lambda (\hat{i} + \hat{j} + \hat{k}) + \mu (\hat{i} - 2\hat{j} + 3\hat{k})$ in the scalar dot product form is -

- (1) $\vec{r} \cdot (5\hat{i} - 2\hat{j} + 3\hat{k}) = 7$
- (2) $\vec{r} \cdot (5\hat{i} + 2\hat{j} - 3\hat{k}) = 7$
- (3) $\vec{r} \cdot (5\hat{i} - 2\hat{j} - 3\hat{k}) = 7$
- (4) $\vec{r} \cdot (5\hat{i} + 2\hat{j} + 3\hat{k}) = 7$

2) The plane passing through the point (-2, -2, 2) and containing the line joining the point

(1, 1, 1) and (1, -1, 2) makes intercepts on the coordinates axes, the sum of whose lengths is-

- (1) 12
- (2) 6
- (3) 8
- (4) 10

3) Distance between parallel planes $2x + 3y + 4z + 1 = 0$ and $4x + 6y + 8z + 5 = 0$ is

- (1) $\frac{3}{\sqrt{29}}$
- (2) $\frac{3}{2\sqrt{29}}$
- (3) $\frac{7}{\sqrt{29}}$
- (4) None of these

4) A 20m wire is available for fencing off a flower bed which has a shape of circular sector. The radius of the circular sector such that flower bed is of greatest area is :-

- (1) 5
- (2) 2.5
- (3) 10
- (4) 3

5) The rate of a chemical reaction y is given by the formula, $y = kx(a - x)$, where x is the amount of product; a , is the amount of material at the beginning of the reaction and $k > 0$. The value of x for which the rate of chemical reaction will be the maximum is:

- (1) $\frac{a}{4}$
- (2) $\frac{a}{2}$
- (3) $\frac{2}{3}$
- (4) $2a$

6) Let $f(x)$ be differentiable function such that $f(x)$ and $f'(x)$ have opposite signs every where, then -

- (1) $f(x)$ is an increasing function
- (2) $f(x)$ is decreasing function
- (3) $|f(x)|$ is decreasing function
- (4) $|f(x)|$ is increasing function

7) Let $f(x) = (x - 1)e^x + 1$, then :-

- (1) $f(x) \geq 0$ for all $x \geq 0$ and $f(x) < 0$ for all $x < 0$

(2) $f(x) \geq 0$ for all $x \leq 0$ and $f(x) < 0$ for all $x > 0$

(3) $f(x) \geq 0$ for all $x \in \mathbb{R}$

(4) $f(x) \leq 0$ for all $x \in \mathbb{R}$

8) Equation of the curve to which the family of lines $2x - (p + q)y + 2pq = 0$ are tangents where $p + q + r = 0$ and $pqr = 6$, is -

(1) $x^2 = 12y$

(2) $x^2 = 8y$

(3) $x^2 = 16x$

(4) $x^2 = 12x$

9) If $y = x^3 - c$ and $y = x^2 + ax + b$ touch each other at the point (1, 2), then $\frac{|a| + |b| + |c|}{|a + b - c|}$ is equal to -

(1) 1

(2) 0

(3) 2

(4) None of these

10) The area bounded by the x-axis, part of the curve $y = 1 + x^{-2}$ and the ordinates $x = 1$

& $x = 2$ is divided into equal parts by the ordinate at $x = a$ such that $a = \frac{3 + \sqrt{p}}{8}$, then the value of p is -

(1) 70

(2) 71

(3) 72

(4) 73

11) Area bounded by $x^2y^2 + y^4 - x^2 - 5y^2 + 4 = 0$ is equal to -

(1) $\frac{4\pi}{3} + 2\sqrt{3}$

(2) $\frac{4\pi}{3} - 2\sqrt{3}$

(3) $\frac{4\pi}{3} + \sqrt{3}$

(4) $\frac{4\pi}{3} - \sqrt{3}$

12) The remainder when $(1!)^2 + (2!)^2 + (3!)^2 + \dots + (100!)^2$ is divided by 144, is -

(1) 17

(2) 31

(3) 33

(4) 41

13) If in the expansion of $(1 + y)^n$, the coefficient of 5th, 6th and 7th terms are in A.P., then positive integer n is equal to -

(1) 7, 11

(2) 7, 14

(3) 8, 16

(4) None of these

14)
$$\sum_{r=0}^{n-1} \frac{{}^nC_r}{{}^nC_r + {}^nC_{r+1}} =$$

(1) $\frac{n}{2}$

(2) $\frac{n+1}{2}$

(3) $(n+1) \frac{n}{2}$

(4) $\frac{n(n-1)}{2(n+1)}$

15) $(A \cap B)^C \cap A$ is equal to -

(1) B

(2) $A \cap B$

(3) $A \cup B$

(4) $A - B$

16) The value of parameter m for which $\int_0^{\pi} (\sin x - mx(\pi - x))^2 dx$ is minimum is $\frac{k}{\pi^5}$, then k must be -

(1) 30

(2) 60

(3) 90

(4) 120

17) If the imaginary part of the expression $\frac{e^{i\theta}}{z-2} + \frac{z-2}{e^{i\theta}}$ is zero, then the locus of z is (where θ is a constant such that $\theta \neq \arg(z-2)$)

(1) a straight line parallel to x-axis

(2) a parabola

(3) a circle of radius 1 and centre (2, 0)

(4) a straight line parallel to y-axis

18) Number of complex numbers z such that $|z| = 1$ and $\left| \frac{z}{\bar{z}} + \frac{\bar{z}}{z} \right| = 1$ is

- (1) 4
- (2) 6
- (3) 8
- (4) More than 8

19) If $f(x) = \begin{cases} Ax + 3 & x < 1 \\ 2 & x = 1 \\ B + x^2 & x > 1 \end{cases}$ is continuous for all $x \in \mathbb{R}$, then A,B are :

- (1) (-1, 0)
- (2) (0, 1)
- (3) (-1, 1)
- (4) (0, 0)

20) If $f(x) = \begin{cases} (\cot x)^{\cos x} \cdot (\cos x)^{\cot x} & , x \neq \frac{\pi}{2} \\ k & , x = \frac{\pi}{2} \end{cases}$ is continuous at $x = \frac{\pi}{2}$, then $k =$

- (1) 0
- (2) $\frac{1}{2}$
- (3) 1
- (4) 2

21) If $x = \int_0^{t^2} e^{\sqrt{z}} \left\{ \frac{2 \tan \sqrt{z} + 1 - \tan^2 z}{2\sqrt{z} \sec^2 \sqrt{z}} \right\} dz$ and $y = \int_0^{t^2} e^{\sqrt{z}} \left\{ \frac{1 - \tan^2 \sqrt{z} - 2 \tan \sqrt{z}}{2\sqrt{z} \sec^2 \sqrt{z}} \right\} dz$. Then the inclination of the tangent to the curve at $t = \frac{\pi}{4}$ is

- (1) $\frac{\pi}{4}$
- (2) $\frac{\pi}{3}$
- (3) $\frac{\pi}{2}$
- (4) $\frac{3\pi}{4}$

22) If $f(x) = ae^{2x} + be^x + cx$ satisfies the conditions $f(0) = -1$, $f'(\log 2) = 31$, $\int_0^{\log 4} (f(x) - cx) dx = \frac{39}{2}$, then :

- (1) $a = 5$
- (2) $b = 6$
- (3) $c = 2$
- (4) $a = 3$

23) If $A = \begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix}$ and $\det(A^n - I) = 1 - \lambda^n$, $n \in \mathbb{N}$ then λ is :

- (1) 1
- (2) 2
- (3) 3
- (4) 4

24) If $F_1(2\sqrt{6}, 0)$, $F_2(-2\sqrt{6}, 0)$ and P is any point on the curve $25x^2 + 49y^2 = 1225$, then $PF_1 + PF_2$ equals -

- (1) 8
- (2) 7
- (3) $4\sqrt{6}$
- (4) 14

25) If $\sin\alpha$ and $\cos\alpha$ are the roots of the equation $ax^2 - bx + c = 0$, $a \neq 0$, then $\cos^{-1}(a^2 + 2ac - b^2)$ is equal to

- (1) 0
- (2) 1
- (3) $\frac{\pi}{2}$
- (4) π

26) Number of solutions of $\tan^{-1}|x| - x^2 = 0$ is/are

- (1) 0
- (2) 1
- (3) 2
- (4) 3

27) A 12 digit number starts with 2 and all its digits are prime, then the probability that the sum of any two consecutive digits of the number is prime is $\frac{1}{2^k}$, where k is equal to -

- (1) 18
- (2) 16
- (3) 14

(4) 12

28) Set of values of x satisfying the inequality $\frac{(x-3)^2(2x+5)^2(x-7)}{(x^2+x+1)(3x+6)^2} \leq 0$ $[a, b) \cup (b, c]$ then $2a + b + c$ is equal to-

(1) 0

(2) 2

(3) 5

(4) 7

29) The sum to n terms of the series

$\frac{3}{1^2} + \frac{5}{1^2 + 2^2} + \frac{7}{1^2 + 2^2 + 3^2} + \dots$ is

(1) $\frac{3n}{n+1}$

(2) $\frac{6n}{n+1}$

(3) $\frac{9n}{n+1}$

(4) $\frac{12n}{n+1}$

30) A tank is initially empty. Water is flowing inside the tank at the rate which is inversely proportional to the quantity of water present inside the tank. If it takes 1 hour for the tank to be completely filled then time taken for the water to occupy half the volume of the tank is equal to -

(1) 15 min

(2) 20 min

(3) 30 min

(4) 45 min

31) ABCD is a rhombus. Its diagonal AC and BD intersect at the point M and satisfy $BD = 2AC$. If the points D and M represent the complex number $(1 + i)$ and $(2 - i)$ respectively, then complex number represented by A can be -

(1) $1 - \frac{3}{2}i$

(2) $1 + \frac{3}{2}i$

(3) $\frac{3}{2}i$

(4) $3 + \frac{i}{2}$

32) $\tan 20^\circ \cot 10^\circ \cot 50^\circ$ is equal to -

- (1) $\frac{1}{\sqrt{3}}$
- (2) $\sqrt{3}$
- (3) $\frac{\sqrt{3}}{4}$
- (4) $4\sqrt{3}$

33) Value of $\sqrt{\cos^2 10^\circ + \cos^2 50^\circ - \sin 40^\circ \sin 80^\circ}$ is equal to -

- (1) $\sin \frac{\pi}{3}$
- (2) $\sin \frac{\pi}{6}$
- (3) $\cos \operatorname{ec} \frac{\pi}{3}$
- (4) $\sec \frac{\pi}{6}$

34) If $\frac{\sin 3A}{\sin A} = k$, then k lies in -

- (1) $-1 \leq k \leq 3$
- (2) $-1 < k \leq 3$
- (3) $-1 \leq k < 3$
- (4) $-1 < k < 3$

35) If $\tan \alpha = \frac{m}{m+1}$ and $\tan \beta = \frac{1}{2m+1}$, then $\alpha + \beta =$

- (1) $\frac{\pi}{3}$
- (2) $\frac{\pi}{4}$
- (3) $\frac{\pi}{6}$
- (4) None of these

36) If $\log_3(\alpha + \beta) + \log_3(\gamma + \delta) \geq 2$ where $\alpha, \beta, \gamma, \delta$ are positive real numbers, then the minimum value of $\alpha + \beta + \gamma + \delta$ is :

- (1) 2
- (2) 3
- (3) 6
- (4) 9

37) A point whose coordinates is (3, -3) is reflected about x-axis, then it is moved along the line $y - x = 0$ by $2\sqrt{2}$ unit distance away from the origin and then the point is rotated about origin by 45° anticlockwise. Then the coordinates of the point in final position is -

- (1) (5, 5)

(2) (3, 3)

(3) $(0, 5\sqrt{2})$

(4) $(5\sqrt{2}, 0)$

38) $f(x) = ax^2 + bx + 2$; $a, b \in \mathbb{R}$. If $f(x) \geq 0; \forall x \in \mathbb{R}$, then the greatest possible value of $b - 4a$ is -

(1) $\frac{1}{4}$

(2) $\frac{1}{2}$

(3) $-\frac{1}{4}$

(4) $-\frac{1}{2}$

39) If slope of the straight line through the point $(-2, 3)$ whose distance from the point $(3, 1)$ has the least value is $\frac{m}{2}$, then m is equal to -

(1) - 5

(2) 5

(3) $-\frac{5}{2}$

(4) $\frac{2}{5}$

40) If $\sin x + \sin y = \frac{1}{2}$, $\cos x + \cos y = \frac{\sqrt{3}}{2}$, $\cos(x + y) = \frac{m}{n}$, ($m, n \in \mathbb{N}$), then $m + n$ is -

(1) 3

(2) 1

(3) 2

(4) 4

PART-IV(A) : English Proficiency

1) Select the most suitable alternative to replace the underlined phrase in the given sentence to make the sentence grammatically correct. I got the best surprise on my 21st birthday this year when Rita gifted me beautiful five tiny orange fish.

(1) No Change

(2) Five tiny beautiful orange fish

(3) Five orange beautiful tiny fish

(4) Five beautiful tiny orange fish

2) Choose the word which is opposite in meaning of the underlined word in the given sentence. Crestfallen she returned home as she had never faced such insult in life

- (1) triumphant
- (2) vainglorious
- (3) distressed
- (4) placated

3) Unscramble the given letters to find the hidden word that is used to call a person who can speak many languages.
OOYTPGLL

- (1) LYGOLOPT
- (2) POLYGLOT
- (3) GLOOPTLY
- (4) None of these

4) Fill in the blank with a suitable helping verb. She is one of those dancers who _____ recently been awarded the Padma Shri.

- (1) has
- (2) have
- (3) had
- (4) will

5) Choose the correct passive voice of the following sentence.
Did he notice your new hairstyle?

- (1) Was your new hair style noticed by him?
- (2) Had your new hairstyle noticed by him?
- (3) Did your new hairstyle noticed by him?
- (4) Is your new hairstyle noticed by him?

6) Choose the word which is nearly same in meaning of the underlined word in the given sentence.
Enmeshed by the financial difficulties, he decided to start a new company and try his luck in export business.

- (1) Repudiated
- (2) Liberated
- (3) Entangled
- (4) None of the above

7) Fill in the blank with the subject and correct form of verb given in the bracket.
What's the problem? Why _____? (you/ cry)

- (1) you have cried
- (2) you cried

(3) had you been crying

(4) are you crying

8) Fill in the blanks with suitable referents.

No one on Welham Girls' School team _____ to care about submitting _____ applications in time.

(1) seems; their

(2) seem; their

(3) seems; her

(4) seem; her

9) The given sentence is divided into four parts (a, b, c and d) which are jumbled up and do not make a meaningful sentence. Rearrange the given parts to form a grammatically correct sentence

a) the lack of concern about global warming among the conservationists,

b) may result in collective suicide

c) Given the importance of plants to human survival,

d) especially when the government is also not taking any corrective measures,

Given the importance of plants to human survival, the lack of concern about global warming among the conservationists, especially when the government is also not taking any corrective measures, may result in collective suicide.

(1) No Change

(2) cabd

(3) cdab

(4) cadb

10) Identify the sentence that maintains a parallel structure

(1) Aerial looked for Mindy the cat in the living hall, in the veranda, and as well as under the kitchen slab, but it was nowhere to be found.

(2) Aerial looked for Mindy the cat in the living hall, in the veranda, and in the kitchen, but it was nowhere to be found.

(3) Aerial looked for Mindy the cat in the living hall, she looked in the veranda, and in the kitchen, but it was nowhere to be found.

(4) None of the above

PART-IV(B) : Logical Reasoning

1) In a certain language if ENDEAR is coded as 123157 and STEADY is coded as 681539, then state which is the correct code for below word SEDATE

(1) 613521

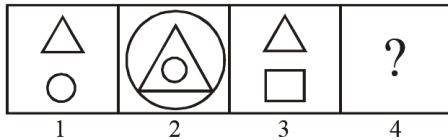
(2) 814165

(3) 954175

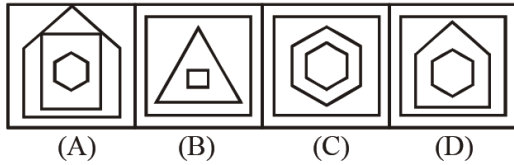
(4) 613581

2) Select a suitable figure from the Answer Figures that would replace the question mark (?).

Problem figure :



Answer figure :



- (1) A
- (2) B
- (3) C
- (4) D

3) Which number will come in the series in place of ?

5, 12, 33, ?, 285, 852..

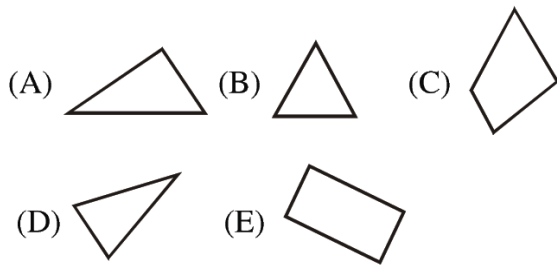
- (1) 92
- (2) 69
- (3) 58
- (4) 96

4) **Direction** : Read the below passage and answer the questions accordingly: It is very difficult to reconcile the ideas of different schools of thought about the question of education system. Some people assume that pupils of school should concentrate on a defined range of subjects which will benefit them directly in their subsequent careers. Others contend that they should study a wide range of subjects so that they not only have the specialized knowledge necessary for their chosen careers but also sound knowledge about the world they will have to work and live in. Supporters of the first theory state that the greatest contributions to civilization are made by those who are expert in their trade or profession. Those on the other side say that, unless they have a broad general education, the experts will be too narrow in their outlook to have sympathy with their fellows or a proper sense of responsibility towards humanity as a whole.

School of thought' can best be explained as:

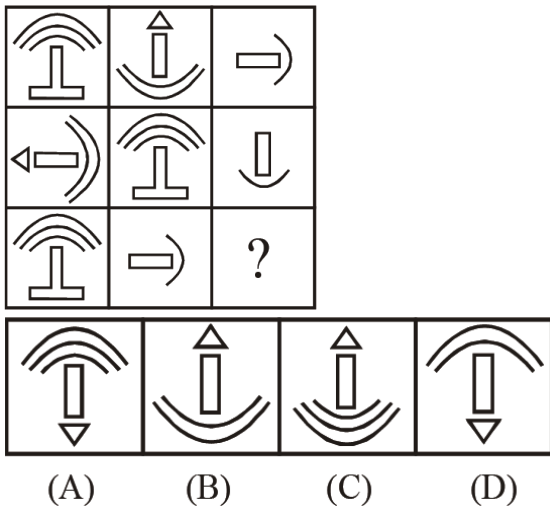
- (1) Groups of people who are schooled to think
- (2) Groups of people having different perception on a particular subjects
- (3) Groups of people belonging to different schools
- (4) Groups of people whose job is to think

5) A set of five figures (A), (B), (C), (D) and (E) are followed by four combinations as the alternatives. Select the alternative which represents the combination of figures which if fitted together, will form a complete triangle.



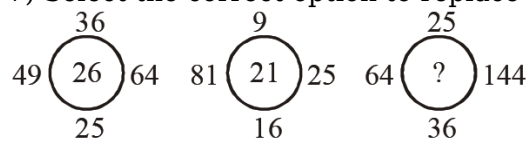
- (1) BCD
- (2) CEB
- (3) BCA
- (4) ABD

6) Choose the alternative which is closely resembles the Figure Matrix of given figure



- (1) A
- (2) B
- (3) C
- (4) D

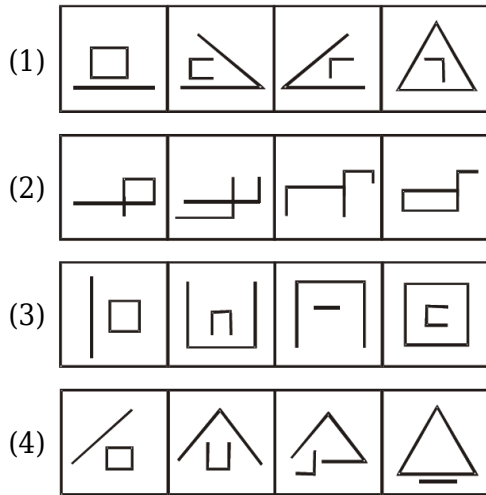
7) Select the correct option to replace the question mark in the given figure.



- (1) 23
- (2) 19
- (3) 31
- (4) 56

8) Which of the following series of figures follows the given rule?

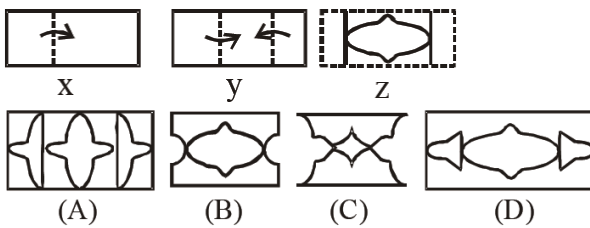
Rule: Open figure becomes more and more closed, and the closed figure becomes more and more open.



9) Which one does not belong to the group?

- (1) 30 - 20
- (2) 18 - 15
- (3) 47 - 29
- (4) 32 - 20

10) Choose a figure which would most closely resemble the unfolded form of Figure (Z).



- (1) A
- (2) B
- (3) C
- (4) D

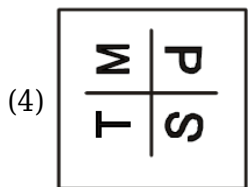
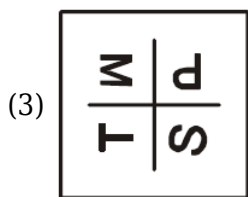
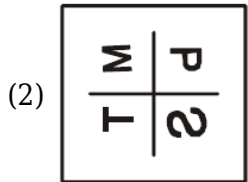
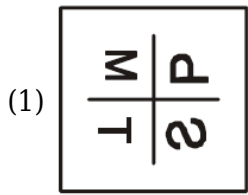
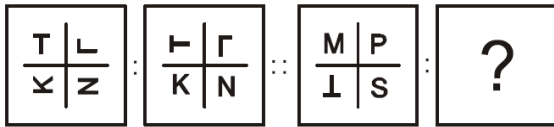
11) Find the missing one from the given altenatives.

64 : 100 :: 16 : ?

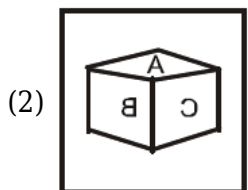
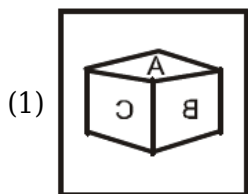
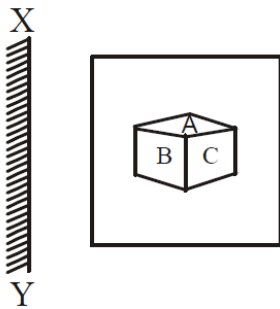
- (1) 25
- (2) 36
- (3) 50
- (4) 55

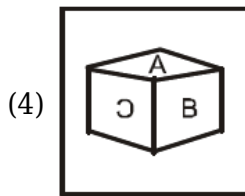
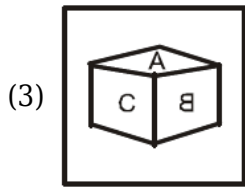
12) **Direction** : In the following questions there is a relationship between the two words/letters/numbers and figures given to the left of the proportionality (: :) sign. The same relationship exists between the words/letters/numbers/figures given to the right of the sign (: :), of which one is missing.

Find the missing one from the given altenatives.



13) **Direction:** If a mirror is placed at XY position then which of the answer figure is exactly a mirror image of the problem figure?





14) **Direction:** If a mirror is placed at XY position then which of the answer figure is exactly a mirror image of the problem figure?

Deepak is the brother of Anil. Deepak is the son of Sunil. Bimal is Sunil's father. How is Anil related to Bimal?

- (1) Son
- (2) Grandson
- (3) Brother
- (4) Grand Father

15) How many letters are there in the word 'MONKEY' which remain in the same position if the letters are arranged in descending order alphabetically?

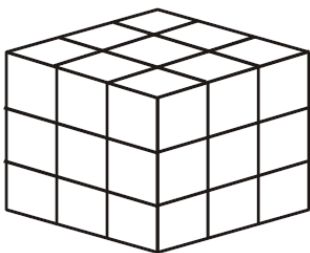
- (1) None
- (2) One
- (3) Two
- (4) Three

16) In the given number series, how many 6 are there which are preceded by odd number and followed by even number.

3 6 2 5 6 3 2 6 2 7 6 4 6 5 8 6 7 6 4 2 6 8

- (1) 2
- (2) 4
- (3) 3
- (4) 1

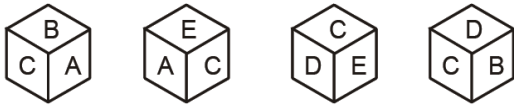
17) Count the number of similar sized cubes in the given figure.



- (1) 18

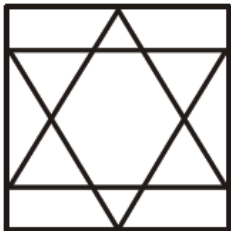
- (2) 27
- (3) 20
- (4) 30

18) Four positions of dice are given below. Which letter will be opposite to D?



- (1) D
- (2) B
- (3) A
- (4) C

19) How many triangles are there in the given squares?



- (1) 18
- (2) 16
- (3) 12
- (4) 14

20) In the following question, five words are given. Which of them will come in the middle, if all of them are arranged alphabetically as in a dictionary? Hobby, Holiday, Hoarse, Hollow, Hobble

- (1) Hoarse
- (2) Hobble
- (3) Hobby
- (4) Holiday

ANSWER KEYS

PART-I : PHYSICS

Q.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A.	3	4	1	2	4	3	3	4	3	3	3	2	4	2	4	4	1	3	1	3
Q.	21	22	23	24	25	26	27	28	29	30										
A.	1	3	4	1	3	1	4	1	2	1										

PART-II : CHEMISTRY

Q.	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
A.	4	3	2	4	2	4	3	3	1	4	4	2	4	3	1	4	2	2	4	2
Q.	51	52	53	54	55	56	57	58	59	60										
A.	4	4	3	4	4	3	4	4	4	4										

PART-III : MATHEMATICS

Q.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
A.	3	1	2	1	2	3	3	1	1	4	1	4	2	1	4	4	3	3	3	3
Q.	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
A.	4	1	2	4	3	4	2	1	2	1	1	2	1	3	2	3	3	2	2	1

PART-IV(A) : English Proficiency

Q.	101	102	103	104	105	106	107	108	109	110
A.	4	1	2	2	1	3	4	3	4	2

PART-IV(B) : Logical Reasoning

Q.	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130
A.	4	2	4	2	3	2	3	4	1	2	3	4	1	2	3	3	2	3	1	3

SOLUTIONS

PART-I : PHYSICS

1) $[V] = L^3$

$$\frac{[A]}{[L]} = L$$

2) Area $1.5 \times 1.203 = 1.8045 \text{ cm}^2 = 1.8 \text{ cm}^2$

3) $VS = 4$, $MS = 2.7$

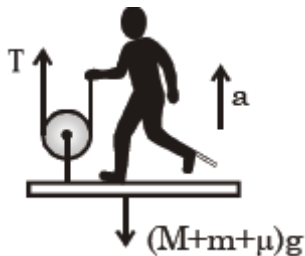
$$= MS + VS \times LC$$

$$= 2.7 + 0.04 = 2.74$$

4) $H_{\max} = \frac{u^2}{2g}$, time to reach at $H_{\max} = \frac{u}{g}$ when

$$H = \frac{H_{\max}}{2}, \text{ applying work-energy theorem}$$

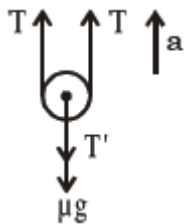
$$-mgH = -\frac{1}{2}mu^2 + \frac{1}{2}mv^2 \Rightarrow v = \frac{u}{\sqrt{2}}$$



6)

$$T - (M + m + \mu)g = (M + m + \mu)a$$

$$T - (M + m + \mu)(g + a)$$



$$2T - T - \mu g = \mu a$$

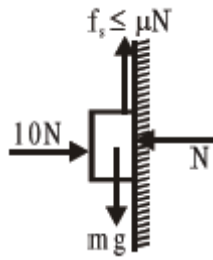
$$T = (2M + 2m + \mu)(g + a)$$

7) Acceleration of heavier block

$$(3N \text{ weight}) = g \sin 37^\circ$$

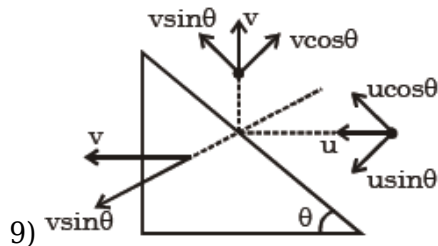
8) 10 N is minimum force to hold stationary,

$$\text{so, } f_s = m(10) = 2N$$



Contact force

$$R = \sqrt{N^2 + f^2} = \sqrt{10^2 + 2^2} = 2\sqrt{26}\text{N}$$



9) $v \sin \theta - (-v \cos \theta) = e u \sin \theta$

$$e = \frac{v \sin \theta + v \cos \theta}{u \sin \theta}$$

$$= \frac{v}{u} + \frac{v}{u} \cot \theta$$

From COM $v = \frac{mu}{M}$

& $v \sin \theta = u \cos \theta$

$$\frac{v}{u} = \cot \theta$$

$t \Rightarrow 0 \text{ to } 2 \text{ sec}$

$$N = mg + ma \Rightarrow 2(10 + 1) = 22 \text{ N}$$

$t \Rightarrow 2 \text{ to } 3$

$$N = mg = 20 \text{ N}$$

$t \Rightarrow 3 \text{ to } 4$

$$N = mg - ma = 20 - 2 \times 2 = 16$$

$$w_1 = 22 \times \frac{1}{2} \times (1) \times (2)^2 = 44$$

$$w_2 = 20 \times (2 \times 11) = 40$$

$$w_3 = 16 \times \frac{1}{2} \times (2) \times (1)^2 = 16$$

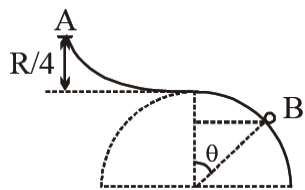
10) $w_{\text{total}} = 44 + 40 + 16 \Rightarrow 100 \text{ J}$

11) Conserving energy between points A & B,

$$mgl \left[\frac{R}{4} + R(1 - \cos \theta) \right] = \frac{1}{2}mv^2$$

Also EFD at point B will give,

$$mg \cos \theta = \frac{mv^2}{R}$$



$$\therefore \frac{1}{4} + (1 - \cos \theta) = \frac{1}{2} \cos \theta$$

$$\frac{5}{4} = \frac{3}{2} \cos \theta$$

$$\therefore \cos \theta = \frac{5}{6}$$

$$12) \text{ KE} = \frac{1}{2} \frac{MR^2}{2} \left(\frac{V}{R} \right)^2 = \frac{Mv^2}{4}$$

$$13) v_{cm} = v$$

$$K_{sys} = \frac{1}{2} (2m) v_{Ac}^2 + \frac{1}{2} m v_{Bc}^2 = 0$$

$$P = 2m v_{AB} = 0 \quad [\because V_{AB} = 0]$$

$$L = \ell (2m) V_{AB} = 0$$

$$14) \text{ T. E. in orbit - P E at surface}$$

$$= \frac{-GM_em}{2(3R)} - \left(\frac{-GM_em}{R} \right)$$

$$= GM_em \left(\frac{1}{R} - \frac{1}{6R} \right)$$

$$= \frac{5GM_em}{6R} = \frac{5}{6} mgR$$

$$15) Y = \frac{Fl}{A\Delta l} \Rightarrow \Delta l = \frac{Fl}{AY} = \frac{F}{VY} l^2 \Rightarrow \Delta l \propto l^2$$

$$\frac{2}{3} v \rho_1 g = v \rho g \quad \dots (i)$$

$$\frac{3}{4} v \rho_2 g = v \rho g \quad \dots (ii)$$

$$v \rho_1 + v \rho_2 = 2v \rho_m; \quad \frac{\rho_1 + \rho_2}{2} = \rho_m;$$

$$v' \left(\frac{\rho_1 + \rho_2}{2} \right) g = v \rho g; \quad \frac{v'}{2} \left[\frac{3\rho g}{2} + \frac{4\rho g}{3} \right]$$

$$= v \rho g;$$

$$16) v' = \frac{12}{17} v$$

$$19) B = 10 \log_{10} \frac{I}{I_0}$$

$$7 = \log_{10} \frac{I}{10^{-12}}$$

$$I = (10^7) \times (10^{-12}) = 10^{-5}$$

$$21) PV^{3/2} = \text{constant and } PV = nRT$$

$$V^{1/2}T = \text{const.}$$

$$\Rightarrow \left(\frac{V}{2}\right)^{1/2} T^1 = \text{const.}$$

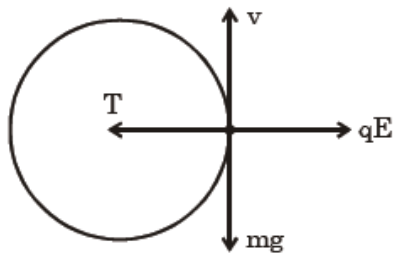
$$\Rightarrow T^1 = T\sqrt{2}$$

$$22) w_g + w_{el} + w_T = K_f - K_i$$

$$-mg\ell + g\frac{mg\ell}{q} + 0$$

$$\frac{1}{2}mv^2 - \frac{1}{2}mu^2$$

$$v = \sqrt{2g\ell}$$



$$T - qE = \frac{mv^2}{\ell}$$

$$23) U_i = \frac{Kq^2}{3d} + \frac{Kq^2}{d} \quad K_i = 0$$

$$U_f = \frac{Kq^2}{2d} + \frac{Kq^2}{2d} \quad K_f = ?$$

$$24) v_d \text{ is of the order of few mm/sec.}$$

$$25) R_1 = \frac{(220)^2}{60}, R_2 = \frac{(220)^2}{100}$$

$$V_{\text{Break down}} \times \frac{R_1}{R_2 + R_1} = 220$$

$$26) \text{ By Gaus's law of magnetism.}$$

$$\Phi_T = 0 = -1 + 2 - 3 + 4 - 5 + \Phi$$

$$\Phi = 3\text{Wb}$$

$$28) i_3 = i_1 + i_2$$

$$= 5 \left(\frac{3}{5} \sin \omega t + \frac{4}{5} \cos \omega t \right)$$

$$= 5 \left(\sin \omega t \cdot \cos 53^\circ + \cos \omega t \cdot \sin 53^\circ \right)$$

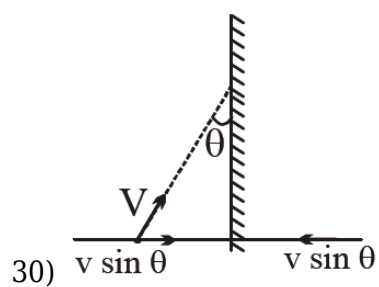
$$= 5 \sin(\omega t + 53^\circ)$$

$$29) \frac{I_0}{2} = I_0 \cos^2 \frac{\Delta \phi}{2}$$

$$\cos^2 \frac{\Delta \phi}{2} = \frac{1}{2} \Rightarrow \Delta \phi = \frac{\pi}{2}$$

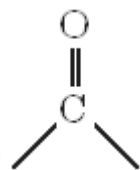
$$\Delta x = \frac{\lambda}{4} = (\mu - 1)t$$

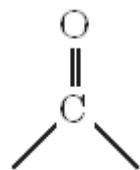
$$\Rightarrow t = \frac{\lambda}{2}$$



PART-II : CHEMISTRY

40)



Reactivity of  group can be increased towards Nucleophilic addition reaction by increasing withdrawing groups as well as decreasing steric crowding

* Reactivity towards N.A.R. = Aldehyde > Ketone

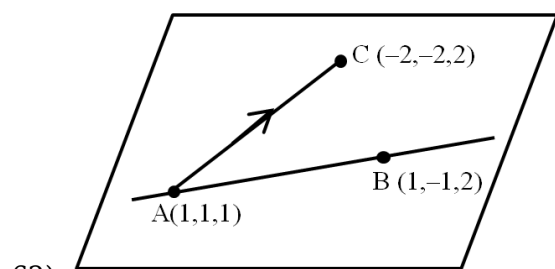
* $-\text{CCl}_3$ is a -I group

* $-\text{Ph}$ is +M group

* $-\text{CH}_3$ is +I group

So reactivity order : I > III > II > IV

PART-III : MATHEMATICS



$$\vec{n} = \vec{AB} \times \vec{AC}$$

$$\begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & -2 & 1 \\ -3 & -3 & 1 \end{vmatrix} = \hat{i} - 3\hat{j} - 6\hat{k}$$

Equation of Plane

Equation of plane

$$1(x-1) - 3(y-1) - 6(z-1) = 0$$

$$x - 3y - 6z - 1 + 3 + 6 = 0$$

$$x - 3y - 6z + 8 = 0$$

$$x - \text{intercept} = -8$$

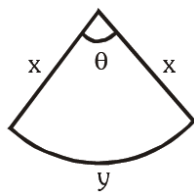
$$y = \text{intercept} = \frac{8}{3}$$

$$z = \text{Intercept} = \frac{8}{6} = \frac{4}{3}$$

$$\text{sum} = |-8| + \frac{8}{3} + \frac{4}{3} = 8 + 4 + 12$$

$$\text{sum} = |-8| + \frac{8}{3} + \frac{4}{3} = 8 + 4 + 12$$

$$\text{sum} = |-8| + \frac{8}{3} + \frac{4}{3} = 8 + 4 + 12$$



64)

$$2x + y = 20$$

$$A = \frac{y}{2x} \cdot x^2 = \frac{y}{2} \cdot x = (20 - 2x) \frac{x}{2}$$

$$A' = \frac{20 - 4x}{2}$$

$$x = 5$$

$$65) \frac{dy}{dx} = k[a - x - x] = 0$$

$$\Rightarrow x = \frac{a}{2}$$

$$66) \text{ Let } g(x) = |f(x)|$$

$$\text{if } f(x) > 0 \text{ and } f'(x) < 0$$

$$\text{then } g(x) = f(x) \Rightarrow g'(x) = f'(x) < 0$$

$$\Rightarrow g(x) \text{ is decreasing}$$

$$\text{Now if } f(x) < 0 \text{ and } f'(x) > 0$$

$$\Rightarrow g(x) = -f(x) \Rightarrow g'(x) = -f'(x) < 0$$

$$\Rightarrow g(x) \text{ is decreasing.}$$

$$67) f(x) = (x-1)e^x + 1, f(0) = 0$$

$$f'(x) = xe^x$$

$$\Rightarrow f(x) \text{ increasing for } x \geq 0 \text{ and } f(x) \text{ decreasing for } x \leq 0$$

$$\Rightarrow f(x) \geq f(0) \forall x \in \mathbb{R}$$

$$\Rightarrow f(x) \geq 0 \forall x \in \mathbb{R}$$

$$68) 2x - (p + q)y + 2pq = 0$$

$$2x - (-r)y + 2 \cdot \frac{6}{r} = 0$$

$r^2y + 2xr + 12 = 0$ which is quadratic in 'r'.

The equation of the required curve is

$$4x^2 - 4.12y = 0 \Rightarrow x^2 = 12y$$

69) Both curves passes through (1, 2) hence

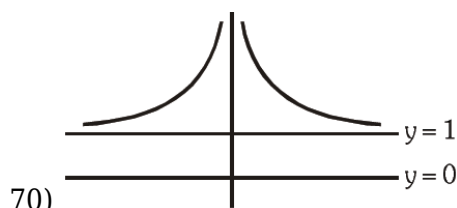
$$2 = 1 - c \text{ and } 2 = 1 + a + b$$

$$\Rightarrow c = -1 \text{ and } a + b = 1$$

$$\text{Also } 3x^2 \Big|_{x=1} = 2x + a \Big|_{x=1} \Rightarrow 3 = a + 2$$

$$\Rightarrow a = 1 \text{ and } b = 0$$

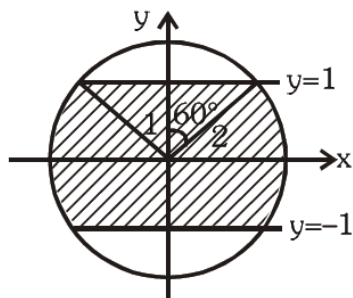
$$\text{Hence } |a| + |b| + |c| = 2 \text{ and } |a + b - c| = 2$$



70)

$$\int_1^a (1 + x^{-2}) dx = \int_a^2 (1 + x^{-2}) dx$$

$$\Rightarrow a = \frac{3 + \sqrt{73}}{8}$$



71)

$$(x^2 + y^2 - 4)(y^2 - 1) = 0$$

Shaded area = Total area - non shaded area Non shaded area

$$= \left(\frac{1}{2} \times 4 \times \frac{2\pi}{3} - \frac{1}{2} \times 2\sqrt{3} \right) \times 2$$

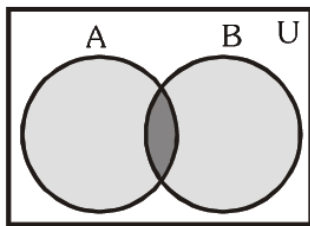
$$= \left(\frac{4\pi}{3} - \sqrt{3} \right) \times 2$$

$\therefore$ Shaded area

$$= 4\pi - \frac{8\pi}{3} + 2\sqrt{3} = \frac{4\pi}{3} + 2\sqrt{3}$$

$$72) (4!)^2, (5!)^2, \dots, (100!)^2 \text{ are divisible by } 144, (1!)^2 + (2!)^2 + (3!)^2 = 41$$

$$\begin{aligned}
 74) \sum_{r=0}^{n-1} \frac{{}^nC_r}{{}^nC_r + {}^nC_{r+1}} \left[{}^nC_r + {}^nC_{r-1} = {}^{n+1}C_r \right] \\
 \Rightarrow \frac{{}^nC_{r+1} + {}^nC_r}{{}^nC_r} = \frac{{}^{n+1}C_{r+1}}{n!} \\
 \frac{{}^{n+1}C_{r+1}}{\frac{(r+1)!}{(n+1)!}} = \frac{(n-1)!}{(n-1)!} (n-1)! \\
 = \frac{(n+1)!}{(n+1)!} \\
 \sum \frac{(r+1)}{(n+1)} = \frac{1}{(n+1)} \\
 \frac{n(n+1)}{2} = \binom{n}{2}
 \end{aligned}$$



75)

From Venn diagram

$(A \cap B)^C$ = Portion

exterior to $A \cap B$

$(A \cap B)^C \cap A$

Portion showing both shading = $A - B$

$$\begin{aligned}
 f(m) &= 2 \int_0^{\pi/2} (\sin x - mx(\pi - x))^2 dx \\
 76) \text{ Let } & 2 \int_0^{\pi/2} \sin^2 x dx + 2 \int_0^{\pi/2} m^2 x^2 (\pi - x)^2 dx \\
 &= -4 \int_0^{\pi/2} mx(\pi - x) \sin x dx \\
 &= \frac{\pi}{2} + 2m^2 \int_0^{\pi/2} (x^4 + \pi^2 x^2 - 2\pi x^3) dx \\
 &\quad - 4m \int_0^{\pi/2} x(\pi - x) \sin x dx \\
 &= \frac{\pi}{2} - \frac{\pi^5}{30} m^2 - 4m\pi \int_0^{\pi/2} x \sin x dx \\
 &\quad + 4m \int_0^{\pi/2} x^2 \sin x dx \\
 \text{or } f(m) &= \frac{\pi}{2} + \frac{\pi^5}{30} m^2 - 4m\pi + 4m(\pi - 2)
 \end{aligned}$$

for $f(m)$ to be min., $f'(m) = 0$

$$\Rightarrow -8 + \frac{\pi^5}{15}m = 0 \quad \text{or} \quad m = \frac{120}{\pi^5}$$

$$\text{At } m = \frac{120}{\pi^5}, f''(m) > 0$$

$$\therefore k = 120$$

$$77) z - 2 = re^{i\alpha}$$

$$\therefore (x-2) + iy = r(\cos \alpha + i \sin \alpha)$$

$$r^2 = (x-2)^2 + y^2 \quad \text{and} \quad \tan \alpha = \frac{y}{x-2}$$

The expression

$$\frac{z-2}{e^{i\theta}} + \frac{e^{i\theta}}{z-2} = re^{i(\alpha-\theta)} + \frac{1}{r}e^{-i(\alpha-\theta)}$$

which is given as real

$$\therefore r \sin(\alpha - \theta) - \frac{1}{r} \sin(\alpha - \theta) = 0$$

$$\Rightarrow r - \frac{1}{r} = 0 \Rightarrow r^2 = 1$$

$$\Rightarrow (x-2)^2 + y^2 = 1$$

$$80) y = \lim_{x \rightarrow \frac{\pi}{2}} (\cot x)^{\cos x}$$

$$\ln y = \lim_{x \rightarrow \frac{\pi}{2}} \cos x \ln (\cot x)$$

$$= \lim_{x \rightarrow \frac{\pi}{2}} \frac{\ln \cot x}{\sec x}$$

$$= \lim_{x \rightarrow \frac{\pi}{2}} \frac{(-\operatorname{cosec}^2 x)}{(\cot x) \sec x \tan x}$$

$$\ln y = 0 \Rightarrow y = e^0 = 1$$

$$y = \lim_{x \rightarrow \frac{\pi}{2}} (\cos x)^{\cot x}$$

$$\ln y = \lim_{x \rightarrow \frac{\pi}{2}} \cot x \ln \cos x$$

$$\ln y = \lim_{x \rightarrow \frac{\pi}{2}} \frac{\ln \cos x}{\tan x}$$

$$= \lim_{x \rightarrow \frac{\pi}{2}} \frac{(-\sin x)}{\cos x \sec^2 x} = \frac{-\sin x \cdot \cos^2 x}{\cos x}$$

$$\ln y = \lim_{x \rightarrow \frac{\pi}{2}} \sin x \cos x = 0$$

$$y = e^0 = 1 = \lim_{x \rightarrow \frac{\pi}{2}} f(x) = 1$$

If function is continuous at $x = \frac{\pi}{2}$, then

$$\lim_{x \rightarrow \frac{\pi}{2}} f(x) = f\left(\frac{\pi}{2}\right) \Rightarrow f\left(\frac{\pi}{2}\right) = 1$$

$$81) \frac{dx}{dt} = e^t \left\{ \frac{2 \tan t + 1 - \tan^2 t}{\sec^2 t} \right\}$$

$$\frac{dx}{dt} = e^t \{ \sin 2t + \cos 2t \}$$

$$\begin{aligned}\frac{dy}{dt} &= e^t \left\{ \frac{1 - \tan^2 t - 2 \tan t}{(1 + \tan^2 t)} \right\} \\ &= e^t \frac{\cos 2t - \sin 2t}{\cos 2t + \sin 2t} \\ \Rightarrow \frac{dy}{dx} \bigg|_{t=\frac{\pi}{4}} &= -1\end{aligned}$$

82) For $x > e$, we know that $1 < \log x < x/e$

$$\begin{aligned}1 &> \frac{1}{\sqrt[3]{\log x}} > \left(\frac{e}{x}\right)^{1/3} \\ \Rightarrow \int_3^4 dx &> 1 > \int_3^4 e^{1/3} x^{-1/3} dx \\ \Rightarrow 1 &> 1 > \frac{3}{2} e^{1/3} (4^{2/3} - 3^{2/3}) \\ \Rightarrow 1 &> 1 > \frac{3}{2} e^{1/3} (16^{1/3} - 9^{1/3}) \\ \Rightarrow 1 &> 1 > 0.92\end{aligned}$$

$$\begin{aligned}83) \quad A &= \begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix} \\ A^2 &= \begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix} \begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix} \\ A^2 &= \begin{bmatrix} 2 & 2 \\ 2 & 2 \end{bmatrix} = 2A \Rightarrow A^3 = 2A^2 \\ &= 2^2 A\end{aligned}$$

Similarly $A^4 = 2^3 A$ and so on

So $A^n = 2^{n-1} A$

$$\begin{aligned}\Rightarrow A^n &= 2^{n-1} \begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix} \\ \Rightarrow A^n - I &= \begin{bmatrix} 2^{n-1} - 1 & 2^{n-1} \\ 2^{n-1} & 2^{n-1} - 1 \end{bmatrix} \\ |A^n - I| &= (2^{n-1} - 1)^2 - (2^{n-1})^2 \\ &= 1 - 2^n \\ \Rightarrow \lambda &= 2\end{aligned}$$

84) The equation of the ellipse can be written as

$$\begin{aligned}\frac{x^2}{49} + \frac{y^2}{25} &= 1 \\ a^2 &= 49 \quad b^2 = 25 \\ b^2 &= a^2(1 - e^2) \\ 25 &= 49(1 - e^2) \\ 1 - e^2 &= \frac{25}{49}\end{aligned}$$

$$e^2 = 1 - \frac{25}{49}$$

$$e^2 = \frac{24}{49}$$

$$e = \frac{2\sqrt{6}}{7}$$

Foci of the ellipse are $(\pm ae, 0)$

$$(\pm 2\sqrt{6}, 0)$$

$$F_1(2\sqrt{6}, 0) \quad F_2(-2\sqrt{6}, 0)$$

So by definition of the ellipse

Since P is any point on the ellipse

$$PF_1 + PF_2 = 2a = 14$$

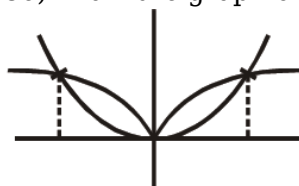
$$85) \sin \alpha + \cos \alpha = \frac{b}{a}, \quad \sin \alpha \cos \alpha = \frac{c}{a}$$

$$\text{Now } (\sin \alpha + \cos \alpha)^2 = 1 + 2 \sin \alpha \cos \alpha$$

$$\Rightarrow \frac{b^2}{a^2} = 1 + \frac{2c}{a}$$

$$\Rightarrow a^2 - b^2 + 2ac = 0$$

86) Draw the graph of $y = \tan^{-1}|x|$ & $y = x^2$



Number of solutions = 3

87) The prime digits are 2, 3, 5, 7.

If we fix 2 at first place, then other eleven places are filled by all four digits.

So, total number of ways = 4^{11} .

Now sum of 2 consecutive digits is prime when consecutive digits are (2,3) or (2, 5), then 2 will be fixed at all alternate places.

2		2		2		2		2		2		
---	--	---	--	---	--	---	--	---	--	---	--	--

So, favourable cases = 2^6

$$\text{Therefore, Required probability} = \frac{2^6}{2^{22}} = \frac{1}{2^{16}}$$

88) From the method of interval -

$$\begin{array}{ccccccc} + & - & - & - & + \\ \hline x \in \left[\frac{5}{2}, \frac{5}{2} \right) \cup (-2, 7] \end{array}$$

$$\therefore (2a+b+c) = 2 \left(-\frac{5}{2} \right) + (-2) + 7 = 0$$

$$89) S_n = \frac{3}{1^2} + \frac{5}{1^2 + 2^2} + \frac{7}{1^2 + 2^2 + 3^2} + \dots$$

$$T_n = \frac{2n+1}{1^2 + 2^2 + \dots + n^2} = \frac{6(2n+1)}{n(n+1)(2n+1)}$$

$$= \frac{6}{n(n+1)} = 6 \left[\frac{1}{n} - \frac{1}{n+1} \right]$$

$$\therefore S_n = T_1 + T_2 + \dots + T_n$$

$$= 6 \left[\left(1 - \frac{1}{2}\right) + \left(\frac{1}{2} - \frac{1}{3}\right) + \left(\frac{1}{3} - \frac{1}{4}\right) + \dots + \left(\frac{1}{n} - \frac{1}{n+1}\right) \right]$$

$$= 6 \left[1 - \frac{1}{n+1} \right] = \frac{6n}{n+1}$$

$$90) \frac{dV}{dt} = \frac{k}{V} \Rightarrow VdV = dkt$$

$$\Rightarrow \frac{V^2}{2} = kt + c \Rightarrow V^2 = mt + n$$

at $t = 0$

$$V = 0$$

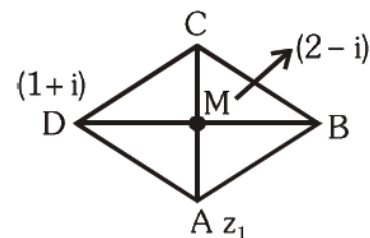
$$\Rightarrow V^2 = mt \text{ at } t = 1 \text{ hour}$$

$$V = V_0 \Rightarrow m = V_0^2 \Rightarrow V^2 = V_0^2 t$$

$$\text{when } V = \frac{V_0}{2} \Rightarrow t = \frac{1}{4} \text{ hr}$$

$$t = 15 \text{ min}$$

$$91) \frac{z_1 - (2-i)}{(1+i) - (2-i)} = \frac{AM}{DM} e^{i\frac{\pi}{2}}$$

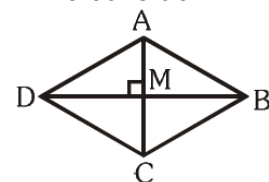


$$z_1 - (2-i) = \frac{i}{2}(-1+2i)$$

$$\Rightarrow 2z_1 = (4-2i) + (-i-2) = 2-3i$$

$$\Rightarrow z_1 = 1 - \frac{3}{2}i$$

If we consider



$$\text{then A is } 3 - \frac{i}{2}$$

$$92) \tan 20^\circ \cdot \tan 80^\circ \cdot \tan 40^\circ = \tan 3(20^\circ) = \sqrt{3} \text{ as}$$

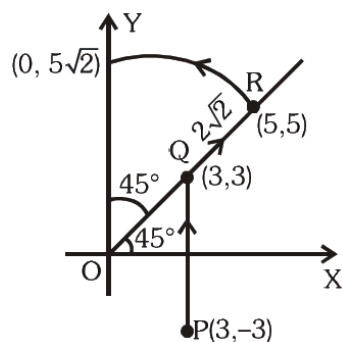
$$\tan \theta \tan(60^\circ - \theta) \tan(60^\circ + \theta) = \tan 3\theta$$

$$\begin{aligned}
 93) E &= \sqrt{1 + \cos^2 10^\circ - \sin^2 50^\circ - \sin 40^\circ \sin 80^\circ} \\
 &= \sqrt{1 + \cos 60^\circ \cos 40^\circ - \frac{\cos 40^\circ - \cos 120^\circ}{2}} \\
 &= \sqrt{1 - \frac{1}{4}} = \frac{\sqrt{3}}{2} = \sin \frac{\pi}{3}
 \end{aligned}$$

$$\begin{aligned}
 94) 3 - 4\sin^2 A &= k \quad \{\sin A \neq 0\} \\
 \Rightarrow \sin^2 A &= \frac{3-k}{4} \Rightarrow 0 < \frac{3-k}{4} \leq 1 \\
 \Rightarrow -1 &\leq k < 3
 \end{aligned}$$

$$\begin{aligned}
 95) \text{ We have, } \tan \alpha &= \frac{m}{m+1} \text{ and } \tan \beta = \frac{1}{2m+1} \\
 \tan(\alpha + \beta) &= \frac{\tan \alpha + \tan \beta}{1 - \tan \alpha \tan \beta} \\
 \text{We know } \frac{\frac{m}{m+1} + \frac{1}{2m+1}}{1 - \frac{m}{m+1} \cdot \frac{1}{2m+1}} &= \frac{2m^2 + m + m + 1}{2m^2 + m + 2m + 1 - m} \\
 &= \frac{2m^2 + 2m + 1}{2m^2 + 2m + 1} = 1 \tan(\alpha + \beta) = \tan \frac{\pi}{4} \\
 \text{Hence, } \alpha + \beta &= \frac{\pi}{4}
 \end{aligned}$$

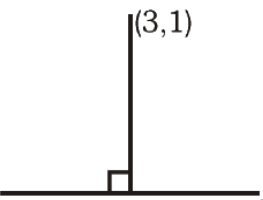
$$\begin{aligned}
 96) \log_3(\alpha + \beta) + \log_3(\gamma + \delta) &\geq 2 \\
 \Rightarrow (\alpha + \beta)(\gamma + \delta) &\geq 2 \\
 \frac{(\alpha + \beta) + (\gamma + \delta)}{2} &\geq \sqrt{(\alpha + \beta)(\gamma + \delta)} \geq 3 \\
 \text{Now, } \Rightarrow \alpha + \beta + \gamma + \delta &\geq 6
 \end{aligned}$$



97)
Reflection of $P(3, -3)$
about x-axis is $Q(3, 3)$

After moving distance of $2\sqrt{2}$ along line $y = x$ coordinates of point are $R(5, 5)$.

$\angle ROX = 45^\circ$ and $OR = 5\sqrt{2}$ Now rotating R about origin by 45° anticlockwise coordinate in final position are $(0, 5\sqrt{2})$



99) $(-2, 3)$ $m/2$ The distance between $(3, 1)$ and $(-2, 3)$ is minimum therefore lines should be perpendicular

$$\left(\frac{1-3}{3+2}\right) \left(\frac{m}{2}\right) = -1$$

$$\Rightarrow m = 5$$

100) $\frac{\sin x + \sin y}{\cos x + \cos y} = \frac{1}{\sqrt{3}}$

$$\tan\left(\frac{x+y}{2}\right) = \frac{1}{\sqrt{3}}$$

$$\cos(x+y) = \frac{1-\frac{1}{3}}{1+\frac{1}{3}} = \frac{3-1}{3+1}$$

$$m+n=3 = \frac{1}{2} = \frac{m}{n}$$

PART-IV(A) : English Proficiency

101) Given adjectives are cumulative adjectives. Correct order of cumulative adjectives in a sentence is as follows: 'quantity, quality, size, age, shape, color, origin/ material, purpose

102) The word 'crestfallen' means 'heartbroken or disappointed due to failures', while the word 'triumphant' means 'victorious or successful'. The two words are opposite in meanings.

103) Person who can speak multiple languages is called polyglot

104) Relative pronoun 'who' connects a clause to the noun placed before it (i.e. dancers). The given sentence is in present tense.

105) When an interrogative sentence in simple past tense is changed to passive voice, the given structure is followed: 'Was/Were+ Object+ Verb₃+ by+ Subject?'

106) Both the words 'enmeshed' and 'entangled' have same meaning i.e. 'to get trapped into something'

107) The first sentence is written in present continuous tense, so the second sentence should also be in the same tense

108) Indefinite pronoun 'no one' is singular and takes singular verb and pronoun

109) because it makes a meaningful sentence.

110) because the three phrases in the sentence that speaks about the possible location of the cat maintains a parallel structure.

PART-IV(B) : Logical Reasoning

111) The alphabets are coded as shown :

E	N	D	A	R	T	S
1	2	3	5	7	8	6

S is coded as 6,

E as 1,

D as 3,

A as 5,

T as 8 and

E as 1

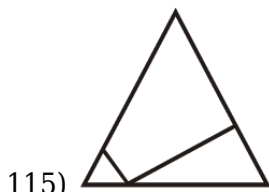
So, SEDATE is coded as 613581.

112) The lower element gets enlarged and becomes the outermost element; the upper element gets slightly enlarged and becomes the middle element and third element which is an original form of lower element appears as the innermost element.

113) Each number in the series is 3 less than thrice the preceding number.

So missing number = $(33 \times 3) - 3 = 96$.

114) School means a particular stream of thinking.



116) There are three types of arrows single, double and triple. Position of arrows is different upwards, downwards and towards right. These arrows have three types of base triangle, plane and rectangle. So missing figure is Option 2.

117) We have : $\sqrt{36} + \sqrt{64} + \sqrt{25} + \sqrt{49} = 26$;

$\sqrt{9} + \sqrt{25} + \sqrt{16} + \sqrt{81} = 21$

So missing number

$\sqrt{25} + \sqrt{144} + \sqrt{36} + \sqrt{64} = (5+12+6+8) = 31$.

118) Following the rule, open figure becomes more and more closed, and the closed figure

becomes more and more open.

119) In all the rest pairs, the difference is divisible by 3.

120) In the following questions there is a relationship between the two words/letters/numbers and figures given to the left of the proportionality ($:$ $:$) sign. The same relationship exists between the words/letters/numbers/figures given to the right of the sign ($:$ $:$), of which one is missing.

121) $8^2 : (8 + 2)^2 :: (4)^2 : (4 + 2)^2$

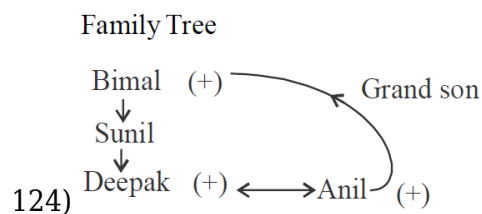
122) Rotate

T $\rightarrow$ Anticlock wise 90°

L $\rightarrow$ Anticlock wise 90°

K $\rightarrow$ Clockwise 90°

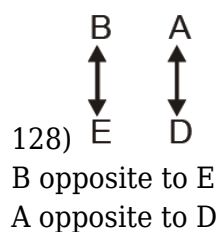
N $\rightarrow$ Anticlock wise 90° .



125) YONMKE

126) $3 \ 6 \ 2 \ 5 \ 6 \ 3 \ 2 \ 6 \ 2 \ 7 \ 6 \ 4 \ 6 \ 5 \ 8 \ 6 \ 7 \ 6 \ 4 \ 2 \ 6 \ 8$
 $= 3$

127) Number of similar sized cubes = 27



129) Number of triangles = 18

130) 1. Hoarse

2. Hobble

3. Hobby

4. Holiday

5. Hollow